MATH 401 DIFFERENTIAL GEOMETRY, FALL 2015

Instructor:	Robert Hardt	**Class Time:**	MWF 3-3:50PM	**Classroom:**	HBH 423
Email:	hardt@rice.edu	**Office:**	HBH 430	**Office Hours:**	MWF 11-12
Course Website:	owlspace.rice.edu				

Course Objectives and Learning Outcomes

To understand the basic concepts of differential geometry of curves and surfaces in space. To be able to determine these in specific examples or use them in elementary proofs.

Required Texts and Materials

Manfredo DoCarmo, *Differential Geometry of Curves and Surfaces*, Prentice Hall, 1976.

Papers, Exams, and Grade Policy

Weekly homework : 45%, midterm exam : 20 %, final exam : 30%, participation : 5%

Absence Policies

Students are expected to contact the instructor in advance for any anticipated absences.

Rice Honor Code

All students will be held to the standards of the Rice Honor Code, a code that you pledged to honor when you matriculated at this institution. If you are unfamiliar with the details of this code and how it is administered, you should consult the Honor System Handbook at http://honor.rice.edu/honor-system-handbook/. This outlines the University's expectations for the integrity of your academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process.

Disability Support Services

If you have a documented disability or other condition that may affect academic performance you should: 1) make sure this documentation is on file with Disability Support Services (Allen Center, Room 111 / adarice@rice.edu / x5841) to determine the accommodations you need; and 2) talk with me to discuss your accommodation needs.

General Subject Description

Differential geometry is the study of geometric figures using the methods of calculus. It has a rich history. See the nice article https://en.wikipedia.org/wiki/Differential_geometry. With origins in cartography, it now has many applications in various physical sciences, e.g., solid mechanics, computer tomography, or general relativity. In this course we develop much of the language and many of the basic concepts of differential geometry by consideration of curves and surfaces in ordinary 3 dimensional Euclidean space. Some of the most striking results in geometry involve relations between local concepts (e.g. the index of a vectorfield or the curvature of a curve or a surface at a point) with a global quantity such as the number of handles of a closed surface. As examples:

Poincaré-Hopf Theorem implies :
Any continuous vectorfield tangent to the sphere must vanish somewhere.
Fary-Milnor Theorem implies :
The total integral curvature of a closed knotted curve is greater than 4π.
Gauss-Bonnet Theorem implies :
The integral of the Gauss curvature over the surface of any topological donut must be zero.

Some of the topics we hope to cover include:

* Parameterized and regular curves, arc length
* The Tangent-Normal-Binormal frame
* Fundamental Theorem of Space Curves
* Isoperimetric Theorem, Turning Tangents Theorem
* Cauchy-Crofton formula
* Mappings, the inverse function theorem, parameterizations
* Parameterized and regular surfaces, level surfaces
* Tangent Plane, differential, first fundamental form
* Orientation and area for surfaces in 3 space
* The Gauss map, Second Fundamental form, mean curvature
* Ruled and minimal surfaces
* Isometries, conformal maps
* Intrinsic versus extrinsic geometry, Gauss's theorema egregrium
* Geodesics, geodesic curvature
* Gauss-Bonnet theorem
* Exponential map
* Constant curvature surfaces
* Optional: Hyperbolic space, Minkowski space-time, Total curvature of closed space curves

Sections to be (tentatively) covered:

Do Carmo, Chapter 1 : 1.1, 1.2, 1.3, 1.4, 1.5, 1.7ABC
Do Carmo, Chapter 2 : 2.1, 2.2, 2.3, 2.4, 2.5, 2.8, Appendix
Do Carmo, Chapter 3 : 3.1, 3.2, 3.3, 3.4, 3.5B(Prop.1 only), Appendix
Do Carmo, Chapter 4 : 4.1, 4.2, 4.3 (except p.236), 4.4(except Prop.4), 4.5
Handouts on ODE, Inverse and Implicit Function Theorems

The handouts, references to other texts, and links to other useful material may be found on the Math 401 Owlspace site.

Syllabus Change Policy

This syllabus is only a guide for the course and is subject to change with advanced notice.